

Use of MPEG-2 System Streams in Digital Motion Imagery Systems

1 Scope

This Recommended Practice (RP) details recommended uses of MPEG-2 system streams in digital motion imagery systems. MPEG-2 Elementary Stream (ES), Transport Stream (TS) and Program Stream (PS) formats are appropriate for use under different circumstances. To promote interoperability, reliable system operation, and system development efficiency this RP limits the use of different MPEG-2 stream types in motion imagery applications.

2 References

ISO/IEC 13818-1:1996, *Information Technology – Generic coding of moving pictures and associated audio information: Systems*

ISO/IEC 13818-2:1996, *Information Technology – Generic coding of moving pictures and associated audio information: Video*

ISO/IEC 13818-3:1996, *Information Technology – Generic coding of moving pictures and associated audio information: Audio*

SMPTE 335M, *Data Encoding Protocol Using Key-Length-Value*

Proposed SMPTE RP, *Non-synchronized Mapping of KLV Packets into MPEG-2 Systems Streams* (DRAFT)

ITU-T Rec. H.262 | ISO/IEC 13818-2:2000/FDAM 1, *Information Technology – Generic coding of moving pictures and associated audio information: Video, AMENDMENT 1: Content Description Data*, ISO/IEC JTC 1/SC 29/WG 11 N3666, October, 2000 (DRAFT)

SMPTE Standard for Television – *Splice Points for MPEG-2 Transport Streams*, SMPTE 312M-1999

Hurst, Norm, and Cornog, Katie, *MPEG-Splicing: A New Standard for Television – SMPTE 312M*, SMPTE Journal, November 1998

3 Introduction

Digital motion imagery systems are being introduced for a variety of military and other Government applications and developers are gaining experience with the MPEG-2 compression format as these systems are built. The purpose of this RP is to capture some aspects of this experience so other developers can use it in their systems.

The guiding principal set forth in Motion Imagery Standards Profile (MISP) 1.7 is that compressed MPEG-2 streams and files must be easily exchangeable among all systems. One way to achieve this is for all motion imagery systems to be interoperable at the file interchange level. Motion imagery systems must make maximum use of commercial standards and products to achieve this. They must also operate reliably and preserve image quality during transmission and exchange.

This RP presents material that will be useful to developers of MPEG-2 digital motion imagery systems to ensure their system's interoperability by setting limits on the use of MPEG-2 ES, TS, and PS formats.

4 MPEG-2 System Streams

This section details when MPEG-2 ES, TS, and PS formats should be used and information that developers of motion imagery systems must consider in their system designs.

4.1 MPEG-2 Elementary Streams

MPEG-2 ES are the most basic MPEG-2 system streams. Their use in digital motion imagery applications as stand-alone files or streams is generally discouraged for the following reasons:

- By definition, an ES is capable of carrying only one essence type (video, audio, or data). The nature of motion imagery collection, exploitation, archive, and distribution functions requires that complex multimedia contents (video, audio, data, and metadata) be carried together in one stream.
- No standards exist for the inclusion of standard KLV metadata into ES formats. Some systems insert KLV metadata into MPEG-2 ES private user packets but these are not implemented uniformly and have not been interoperable.
- MPEG-2 ES is a sub-optimal method for conveying motion imagery information when TS and PS formats have added features. Not all MPEG-2 decoders accept ES inputs.
- The interchange of MPEG-2 ES (without KLV metadata) between systems has proven to be problematic, especially with MPEG-2 software decoders. Due to apparent differences in codec implementations users have experienced difficulty decoding ES created on encoders from different manufacturers. Interoperability criteria require that MPEG-2 streams created on one system be decoded without difficulty by an MPEG-2 decoder or viewer from other manufacturers.

Developers may wish or need to make use of MPEG-2 ES in processes that are internal to closed applications. In some cases ES formats may make sense but still within the limitations mentioned above. Developers are discouraged from using the ES format for any exchange between different applications within a single system or between identical systems.

4.2 MPEG-2 Transport Streams

MPEG-2 TS are preferred over ES for a number of reasons:

- The TS format is intended for use in error-prone transmission environments for either file or streaming media applications. Error-prone environments are typical of what may be experienced by fielded military motion imagery systems. Most TS decoders are able to recover when frames are corrupted in transmission.
- Virtually all MPEG-2 codecs handle the TS format. A very small number of specialized codecs may handle only PS formats but these will likely be replaced in the future by products that handle both TS and PS.
- An MPEG-2 TS may contain multiple video, audio, data, and metadata ES together. This is the preferred method for conveying multimedia streams to ensure their continuous, correct relationship to one another.
- Standard KLV metadata should be contained within a TS as its own ES. Two draft international standards are in standards body coordination that will define how to handle the carriage of metadata both non-synchronously and synchronously in TS.
- Experience has shown that any commercially available decoder can usually decode TS outputs from MPEG-2 codecs reliably. With rare exception, there is universal interoperability of video and audio essence among codecs for the TS format. When KLV is inserted into TS most decoders that cannot read the KLV metadata bypass it without problem.
- Because MPEG-2 TS are used primarily in a streaming environment this is the preferred format when files need to be decoded and viewed immediately upon receipt of the first frames. This is an advantage of the TS over the PS, especially for large files.

Developers must exercise care when building systems that edit or otherwise alter MPEG-2 TS. “Slicing” or segmentation of a TS stream or file into smaller TS or PS files must take into account the GOP (Group of Pictures) structure of the MPEG-2 format and consider the impact of “B” and “P” frames at file boundaries.

4.3 MPEG-2 Program Streams

MPEG-2 PS has some advantages and disadvantages compared to the TS format. There is not enough evidence to prefer the PS format over the TS in every situation so the following characteristics of the PS should be considered carefully when designing a digital motion imagery system.

- The PS was originally developed to convey MPEG-2 in an error-free environment. It lacks the error recovery and redundancy facilities of the TS. For this reason the MPEG-2 PS is used as the DVD video format and for other removable media. It is used in local area networks where errors are not a problem. If MPEG-2 files are to be exchanged on removable media the PS format is the best choice.
- Because DVD media are ubiquitous the number of MPEG-2 PS decoders exceeds 100 million and can be found on any new PC. Other PC-based video player software decoders

readily handle MPEG-2 PS and may (within the next 12-24 months) handle real-time decoding of TS.

- Because the PS is intended for an error-free environment it does not carry the approximately 10% overhead associated with error recovery and redundancy that the TS carries. If this overhead is an issue, and the environment is error-free, then the PS may be preferred over the TS

If a decoder is not able to play a PS but can handle a TS then the PS must first be “split” into TS components before decoding and playing. This is not a complex or computationally intensive operation but must be taken into account if a system must deal with both PS and TS formats.

Developers that choose to use the PS format over the TS are cautioned that not all cuts-only editors are able to handle PS files. This may be a factor in selecting to use a TS format over a PS format.

4.4 Use of TS and PS in Long-term Archives or Libraries

Most users of motion imagery long-term archives or libraries connect to them via error-free networks or receive archived imagery material on removable media. For these applications the storage of compressed motion imagery in the MPEG-2 PS format is recommended. The motion imagery archive must be able to receive MPEG-2 PS files and send these files unaltered to requestors.

Motion imagery files in long-term archives or libraries must also be sent to some users over error-prone communications systems. For this distribution it is recommended that the PS file be converted to the TS format using existing commercially available products. It will be the responsibility of the developer to determine if the conversion is done at the motion imagery archive or library before forwarding to the end user or if the conversion takes place at the uplink or injection point where the file enters the error-prone communications system.